

III. "Effect of Floor-Deafening on the Sanitary Condition of Dwelling Houses." By Miss ETTA JOHNSTONE, University College, Dundee, and THOS. CARNELLEY, Professor of Chemistry in the University of Aberdeen. Communicated by Sir H. ROSCOE, F.R.S. Received February 7, 1889.

"Deafening" is the material which is laid upon boards fitted in between the joists of a floor to prevent the passage of sound into the room below. This material is used largely on the Continent and in many parts of this country, especially in Scotland, and is supposed to consist of a mixture of coarse mortar and smith's ashes, but in general it appears to be of a much more questionable nature, particularly in the case of low-class houses. It is also supposed by some builders to prevent the passage of smell; but houses are known to have been rendered uninhabitable by its presence, the cinders, which form the great bulk of the substance, being more or less contaminated according to the place whence obtained and other attendant circumstances.

With the object therefore of ascertaining whether this material was a serious factor in the pollution and vitiation of the air of dwelling-houses, we undertook the analysis of a number of samples from various classes of houses in Dundee, and the results obtained are recorded in the present paper.

Carnelley, Haldane, and Anderson ('Phil. Trans.,' B., vol. 178 (1887), pp. 61-111) have proved that the number of micro-organisms habitually present in the air of a dwelling-house increases with the age of a building. Indeed, some of the older buildings become perfectly infested with them, as shown not only by the results obtained by the above observers in houses and schools in Dundee, but also by those of Miguel in old and new houses in Paris. Indeed, this floor-deafening when impure would appear to be a remarkably good medium for the propagation of bacteria, other conditions being favourable.

Dr. Emmerich, of Leipzig, some years ago ('Zeitschr. f. Biol.,' 1882) made experiments on the effects of this stuff with regard to the air of rooms, and also analysed numerous samples of pure material, some of which were obtained from new buildings on completion, and some from inhabited houses. He found that on washing the floors of rooms, shutting them up for some time, and then examining the air, there was a great increase of carbonic acid, which must have been due to the putrefaction set up by the moisture on reaching the deafening, as all other known sources of carbonic acid were excluded.

As a result of his investigations, he concluded that "there exists

nowhere in nature, not even in the neighbourhood of human dwellings, a (natural) soil so highly contaminated with nitrogenous organic substances and their decomposition products as the deafening material under the floor of dwelling-rooms."

As some of Emmerich's results appear to have been called in question, and for the purpose of ascertaining whether a similar state of matters exists in houses in this country, we obtained samples of deafening from dwellings in different parts of Dundee, through the kindness of Mr. Kinnear, of the Sanitary Department. Some of these were taken from ordinary middle-class houses, others from one-, two-, and three-roomed houses of the poorer class, while two were obtained from houses (in Fish Street, Dundee) about 200 years old, and occupied by the poorest class of artisans. The deafening from the lower class of houses, and especially that from the oldest houses, had a most disgusting and filthy smell. All the houses examined, even those of the better class, had been built and occupied more than twelve years. For analysis the material was passed through a wire sieve of $\frac{1}{10}$ -inch mesh, and the percentage of fine dust and coarse lumps noted. The fine dust was bottled, and the following substances determined therein by the usual methods:—(1.) Moisture. (2.) Total combustible matter (exclusive of moisture). (3.) Chlorine. (4.) Nitrogen.

The results are given in the following table:—

Table of Results.

No.	Percentage in deafening of—		Percentage in fine matter reckoned on total deafening.					Situation of house in Dundee.
	Coarse matter.	Fine matter.	Moisture.	Mineral matter.	Combustible matter.	Chlorine.	Nitrogen.	
Four-roomed houses and upwards.	1 93.51	6.49	1.01	5.14	0.33	none	none	Dalhousie Terrace (bathroom).
	2 79.43	20.57	3.83	15.16	1.58	"	"	Magdalen Yard Road (bedroom).
	3 74.46	25.54	1.83	16.79	1.92	"	"	Dalhousie Terrace (kitchen).
	4 56.99	33.01	0.57	27.89	4.51	"	"	Clarendon Terrace (nursery).
	5 73.36	26.64	0.54	20.01	6.09	"	"	Hillside, Newport (bedroom).
	6 50.29	49.71	0.91	42.40	6.37	"	"	Clarendon Terrace (bedroom).
	7 63.25	36.75	0.93	27.81	7.95	"	"	James Square, Newport (bedroom).
	8 47.15	52.85	1.18	44.01	7.61	"	"	Clarendon Terrace (nursery).
	9 54.20	45.80	1.53	42.06	2.24	0.032	0.016	Magdalen Yard Road (bedroom).
	10 43.55	56.45	4.83	47.77	3.85	0.016	0.041	Guthrie House.
	11 57.18	42.82	0.80	34.60	7.34	0.025	0.233	St. Mary's Place.
Average...	63.4	36.6	1.63	29.42	4.53	0.006	0.026	
Three-roomed houses.	1 58.41	41.59	0.36	33.76	7.48	0.009	0.019	73, Wilkie's Lane.
	2 65.98	34.02	0.58	27.13	6.30	0.0095	0.025	11, Pennycook Lane.
	3 67.07	32.93	0.83	28.36	3.74	0.018	0.052	13, Kinloch Street.
Average...	63.82	36.18	0.59	29.75	5.84	0.012	0.032	

Table of Results—continued.

	No.	Percentage in deafening of—		Percentage in fine matter reckoned on total deafening.					Situation of house in Dundee.
		Coarse matter.	Fine matter.	Mois- ture.	Mineral matter.	Combustible matter.	Chlorine.	Nitrogen.	
Two- roomed houses.	1	60·93	39·07	1·28	29·22	8·60	0·080	0·134	3, Stewart Street.
	2	47·49	52·51	0·97	49·46	2·08	0·080	0·161	200, Hilltown.
	3	55·60	45·00	2·78	37·63	4·57	0·088	0·175	21, Ogilvie's Road.
	4	61·13	38·87	2·83	32·58	3·45	0·088	0·173	Bell Street.
	5	14·10	85·90	0·93	75·50	9·51	0·088	0·310	3, Watt Street.
	6	4·27	95·73	0·69	90·72	4·31	0·163	0·307	25, Session Street.
Average...	..	40·48	59·52	1·58	52·52	5·42	0·081	0·209	
One- roomed houses.	1	68·09	31·91	0·67	24·03	7·21	0·026	0·115	69, Hilltown.
	2	34·81	65·14	2·85	36·28	26·01	0·138	0·206	Bell Street.
	3	49·78	50·22	1·43	42·91	5·88	0·058	0·225	91, Hilltown.
	4	33·58	66·42	1·13	56·89	8·40	0·075	0·309	35, Union Street.
	5	23·10	76·90	2·07	63·55	11·16	0·373	0·248	Fish Street.*
	6	15·01	84·99	1·82	71·21	11·83	0·386	0·363	Fish Street.*
	7	22·40	77·60	2·86	60·40	14·23	0·311	0·637	Bell Street.
Average...	..	35·25	64·75	1·83	50·75	12·10	0·195	0·300	

* These houses were about 200 years old, and are now pulled down.

The above results show :—

- (1.) That the quality of the deafening, as indicated by the percentage of chlorine, nitrogenous organic matter, and combustible matter, runs strictly parallel with the class of house, being by far the worst in the one-roomed houses, and the best in the largest houses.
- (2.) That the deafening employed in ordinary middle-class houses is in almost all cases practically free from nitrogenous organic matter and chlorides, and from any disagreeable smell, so that no objection can be raised to the use of deafening of the quality we have examined in this class of house.
- (3.) In the poorer class of houses (of three rooms and under) nitrogenous organic matter and chlorides are always present, the percentage being especially high in the older houses, while in many cases the smell is very objectionable. From this it would appear that the air in such houses may be very seriously polluted by the deafening, and thus give rise to ill-health.

In reference to the above results we may remark : (1.) That the cinders, which form the bulk of the deafening used in better class houses are probably of good quality, owing to their being obtained from a non-contaminated source, whereas in the poorer class of houses inferior materials (and possibly ash-pit refuse, &c.) will doubtless be made to serve for filling up the deafening space. (2.) The carpets in the better class of houses are not usually lifted oftener than twice a year, and of course the floors can only be washed at those times, so that the necessary condition of moisture for the growth of micro-organisms is not present to the same extent as in lower-class houses, while at the same time the carpet will act as a partial filter to micro-organisms arising from the deafening material. In the poorer class of houses, however, everything would seem to favour the contamination of the air from this source. The floor boards are often plain jointed, and simply laid side by side, so that when the floor is washed the water has every facility for trickling down to the material beneath. Further, all the household operations of washing, cooking, nursing, &c., have to be carried out in the one or two apartments, and hence the spilling of dirty water, slops, &c., on the floor, and percolation into the deafening below will be of pretty frequent occurrence. The rooms are often overcrowded, and consequently the air is moist and warm, so that the increase and multiplication of micro-organisms would seem to be inevitable.

It has been shown (Carnelley, Haldane, and Anderson, 'Phil. Trans.,' B. (1887), p. 61) that in passing from many to two- and one-roomed houses the air becomes more and more impure, especially with regard to the number of micro-organisms, whilst the death-rate

largely increases, and the mean age at death diminishes. The results of the present paper show that the sanitary condition of the floor-deafening follows a similar order, thus :—

Dundee.		Houses.			
		Four-roomed and upwards.	Three-roomed.	Two-roomed.	One-roomed.
Vital statistics.	Total population	23,007	22,087	79,825	25,410
	Average number of persons per room	1·3	..	3·4	6·6
	Space per person in cubic feet	1,833	..	249	212
	Death-rate per 1000	12·3	17·2	18·8	21·4
	Mean age at death of all who died	40·0	30·6	21·3	20·9
State of the air.	Carbonic acid (vols. per 1000)	7·7	..	9·9	11·2
	Oxidisable organic matter (O required per million vols. of air)	4·5	..	10·1	15·7
	Total micro-organisms per litre	9·0	..	46·0	60·0
State of floor-deafening.	Coarse matter in deafening per cent.	63·40	63·82	40·48	35·25
	Fine matter in deafening per cent.	36·60	36·18	59·52	64·75
	Organic matter per cent.	4·53	5·84	5·42	12·10
	Chlorine per cent.	0·006*	0·012	0·081	0·195
	Nitrogen per cent.	0·026*	0·032	0·209	0·300

The results obtained by the authors referred to above have also shown that the micro-organisms do not come either from the breath (at least in health), nor in large numbers from the outside air, so that it would seem clear that they come from some part of, or material in, the room itself. Though our results are certainly not so marked as those of Dr. Emmerich, they show, nevertheless, quite clearly that the deafening material may be and is in the poorer class of houses a source of contamination of the air of dwellings, in that it furnishes a good and suitable medium for the growth of micro-organisms, and gives off foetid gases from putrefaction, provided the necessary factors, moisture, warmth, and nitrogenous organic matter, are present.

* Had it not been for the abnormally high results obtained in one of these houses in which the drainage was very defective, these numbers would have been very much lower, viz., 0·004 per cent. Cl and 0·0037 nitrogen. Indeed, eight of the eleven houses examined were quite free from both chlorides and nitrogenous organic matter.